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ABSTRACT

Reported are results of a study designed to determine the experimental effect of three low-inference teacher clarity variables on student achievement in science. College students (N=41) were randomly assigned to one of two groups defined by the teacher's clarity in the lesson, i.e., high clarity versus low clarity. After a lesson in basic genetics concepts, the subjects completed a test on the contents of the lesson and then rated the lesson presentation. Students in the high clarity group achieved more (although not significantly) than did students in the low clarity group. Students perceived the high clarity lesson as significantly clearer than the low clarity lesson. (Author/CS)

EFFECT OF TEACHER CLARITY ON STUDENT ACHIEVEMENT IN SCIENCE

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Running Head: Clarity

Abstract

College students ($\underline{N}$ = 41) were randomly assigned to one of two groups defined by the teacher's clarity in the lesson, i.e., high clarity versus low clarity presentation on genetics. After the lesson, the subjects completed a test on the contents of the lesson and then rated the lesson presontation. Students in the high clarity group achieved more (although not significantly) than students in the low clarity group. Student perceived the high clarity lesson as significantly clearer than the low clarity lesson. These findings are discussed in relation to previous research on teacher clarity.

The purpose of this paper is to respond to the call for the use of experimental design and low inference specification of teacher behavior variables in studying their effects on student achievement. Specifically, the research was designed to answer the following questions:

1. What are the joint effects of actual and perceived teacher clarity on student achievement?
2. Do students who perceive a clear lesson as clear achieve more than students who perceive an unclear lesson as unclear?
3. Do students who perceive an unclear lesson as clear achieve more than students who perceive a clear lesson as unclear?
4. What are the joint effects of level of achievement and actual teacher clarity on perceived teacher clarity?
5. What response items are most effective in distinguishing between clear and unclear lessons?
6. Is there any difference between high and low clarity lessons on achievement at the knowledge, comprehension, and application levels?

There are various ways of classifying variables in the research of teaching. Mitzel (1960) and Dunkin and Biddle

(1974) have classified them as presage variables-such as sex and age of the teacher; context variables-such as class size and grade level; process variables-that deal with the way teachers and students act and interact; and product variables-such as the knowledge, behavior, and attitudes that students possess. Yager (1978) has a comparable classification with categories of: antecedents (comparable to presage and context variables); transactions (comparable to process variables); and outcomes (comparable to product variables). Gage (1978) suggested there are six possible pairings of the four types of variables but that those researchers who are interested in a scientific basis for teaching are interested primarily in only one of these pairs: process-product relationships. Butts, Capie, Fuller, May, Okey, and Teany (1978) identified the category "analysis of classroom teaching behaviors that facilitate science learning" as one of the highest ranking research categories as identified by science educators.

The overwhelming majority of the research studies on the effects of teacher behaviors (process) on student learning (product) have been descriptive, primarily correlational, in design. The findings of such research are open to a number of interpretations as to the type of relationship between the variables being studied. To establish cause-and-effect between an independent (teacher) variable and a dependent (student) variable, the researcher must use an experimental design. Another difficulty of previous research is that high inference behavior (nonoperational definitions) have frequently been studied rather than low inference behaviors (operational definition). Therefore, the results of studies using cor-

relational designs and high inference measures are difficult to interpret and almost impossible to replicate.

Teacher clarity was identified by Rosenshine and Furst (1971) as the single most promising teacher process variable among nine variables they identified from correlational process-product studies. Bush, Kennedy, and Cruickshank (1977) have stressed the need for experimental, low inference studies of the effects of teacher clarity on student achievement to determine if that independent variable is causally related to achievement.

The number of low inference measures comprising teacher clarity are not known with certainty. Land and Smith (1979a), however, have hypothesized at least two components of teacher clarity: a) measures associated with the teacher's verbal presentation of the lesson, and b) measures associated with the organization of the content and learning activities. One of the variables identified with component a is teacher mazes: false starts or halts in speech, redundantly spoken words, and tangles of words. On the average, teachers produce almost three mazes per minute. A variable associated with component b is additional unexplained content. Land (1979) defined this variable as additional terms related to the lesson but not essential to the main theme of the lesson. In addition, components a and b can be divided into inhibitive and facilitative behaviors.

The present study is concerned basically with the combined effects of three low inference variables of teacher clarity--

mazes and utterances of "uh" and "ok" -- on student achievement. All three behaviors are associated with the verbal presentation (component a) of teaching and were hypothesized to have an inhibiting effect on learning. Figure 1 presents a summary of the variables in the present study. Land and Smith (1979b) reported that mazes were causally related to student achievement in mathematics (concept and generalization learning at the comprehension and analysis levels). Smith (1977) reported a negative correlation between utterances of "uh" and student achievement in mathematics.

The third variable-utterances of "ok"- was grouped with mazes and "uh" because of the general assumption of professional educators that such utterances in sufficient quantity inhibit student achievement.

The purpose, then, of this study was to determine the experimental effect of three low-inference teacher clarity variables on student achievement in science.

Insert Figure 1 about here

Method

The investigator used a randomized control group, posttest-only design. There were two levels of the independent variable, i.e., high clarity (clear) versus low clarity (unclear). The lessons were written out and then videotaped by the same instructor in order to control for the content and the variables being studied. The only difference in the lessons was the presence or absence of the three variables being studied. The

exact content--basic genetics concepts--was discussed in the same sequence with the same overhead transparency projections. The low clarity (unclear) lesson contained the following teacher clarity behaviors: mazes and utterances of "uh" and "ok" (Figure 1).

The frequency of mazes was 5.1 per minute with a total of 92 in the lesson; the frequency and total for utterances of "uh" was also 5.1 per minute and 92. Utterances of "oh" occurred at the rate of 5.3 per minute with a total of 95 in the lesson. The high clarity (clear) lesson contained none of the inhibitive behaviors associated with the low clarity lesson.

Following are excerpts from the lessons with examples of the low inference behaviors in italics:

CLEAR LESSON (High clarity)

The phenomenon by which one trait appears and the other does not is called dominance. In the example we have just talked about, tallness is a dominant trait in pea height. Tallness is dominant over shortness, which in turn is considered recessive.

UNCLEAR LESSON (Low clarity)

The *event*,[a] *uh*,[b] phenomenon by which one trait appears and the other does not is called dominance, *ok?*[c] In the example we have just *seen*,[a] *uh*,[b] talked about, tallness is a dominant trait in pea height. Tallness is dom-,[a] *uh*,[b] dominant over shortness, which, *uh*,[b] in turn is considered recessive, *ok?*[c]

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a = teacher maze

b = utterance of "uh"

c = utterance of "ok"

The 41 subjects (over 55 percent were female and over 90 percent were of Caucasian ancestry) were undergraduate students enrolled in a general biological science course at a state college in the Midwest. They were freshman and sophomore students ranging in age from 18 to 37 with a median age of 20 years. Over 60 percent of the students came from a background that could be described as rural, middle class. The basic design was randomized control group, posttest only. Subjects were placed randomly into one of two groups--high clarity lesson or low clarity lesson. Subjects were told they were to view an 18-minute lesson on which they were to take notes, then they would be tested over the contents of the lessons but that they could not use their notes. The subjects in both groups took a 24-item criterion referenced test immediately after viewing the tapes. The items on the test were written at the knowledge, comprehension, and application levels of the cognitive domain. The instrument was assumed to have high content validity because each test item reflected an important point in the lesson. The internal reliability of the test measured by the Kuder-Richardson formula was .87. In addition, each student rated the lesson (Figure 2) on a 15-item response form. The test-retest reliability of this instrument was .89.

Insert Figure 2 about here

Results

Research question 1: What are the joint effects of actual and perceived teacher clarity on student achievement?

In the study, "actual teacher clarity" was defined on the basis of the presence or absence of three low inference variables:

mazes, "uh," and "ok" (Figure 1). "Perceived teacher clarity" was inferred from student ratings of the lessons (Figure 2). Students were placed into the high or low perceived clarity groups on the basis of whether their rating was above or below the mean lesson rating. A 2 x 2 analysis of variance was performed on the achievement scores; data are presented in Table 1. The actual clarity main effect was not significant, (F (1,37) = 1.44, $p > .05$, although the high actual clarity groups did achieve higher ($\bar{X}$ = 17.09) than the low clarity groups ($\bar{X}$ = 15.84). The perceived clarity effect was not significant, F (1,37) = 2.62, $p > .05$, although the high perceived clarity groups scored higher ($\bar{X}$ = 17.26) than the low clarity groups ($\bar{X}$ = 16.00). The interaction effect was not significant.

Research question 2: Do students who perceive a clear lesson as clear achieve more than students who perceive an unclear lesson as unclear?

The data used to answer this question came from the students who viewed the high clarity lesson and who also rated that lesson high in perceived clarity (the high-high group in Table 1). The second group was composed of those students who viewed the low clarity lesson and who also rated that lesson low in perceived clarity (the low-low group in Table 1). A t-test was used to analyze the data. The effect was significant for a one-tailed test, t (19) = 2.03, $p < .05$, in favor of the high clarity group.

Research question 3: Do students who perceive an unclear lesson as clear achieve more than students who perceive a clear lesson as unclear?

The data used to answer this question came from the students who viewed the high clarity lesson but who rated it low in perceived clarity (the high-low group in Table 1). The second group was composed of students who viewed the low clarity lesson but who rated it high in perceived clarity (the low-high group in Table 1). The effect was not signigicant, $t\ (18) < 1$, $p > .05$, although the low-high group slightly outscored the high-low group.

Research question 4: What are the joint effects of level of achievement and actual clarity on perceived clarity?

Level of achievement was determined on the basis of the average score on the achievement test. Above-the-mean scores were placed in the high achievement group and below-the-mean scores in the low group (Table 2).

The clarity main effect was significant, $F\ (1,37) = 50.25$, $p < .01$, with students rating the high clarity lesson ($\bar{X} = 43.10$) higher than they rated the low clarity lesson ($\bar{X} = 28.25$). The level of achievement effect was not significant, $F\ (1,37) < 1$, $p > .05$, although the high achievement group rated the high clarity lesson ($\bar{X} = 35.35$) slightly higher than the low clarity lesson ($X = 33.33$). The interaction effect was not significant.

Research question 5: What response items are most effective in distinguishing between clear and unclear lessons?

The 10 items showing the greatest difference in student ratings between clear and unclear lessons are shown in Table 3. The well-organized/not well-organized pairing showed the greatest mean difference.

Research question 6: Is there a difference between high and low clarity lessons on achievement at the knowledge, comprehension, and application levels?

The achievement test consisted of 24 items written at the knowledge, comprehension, and application levels of the cognitive domain. There were 10 items at the knowledge level and 7 items each at both the comprehension and application levels. For comparison purposes, 7 of the 10 knowledge questions were selected at random. The mean results are shown in Table 4. Mean achievement of the high clarity groups was 4.30 while the low clarity groups was 3.95. The knowledge groups scored 4.47, the comprehension groups scored 4.57, and the application groups scored 3.32.

Discussion

The results of this study appear to be a contradiction of the study by Land and Smith (1979b) until one takes into account that their study dealt with the effects of single variables and the present study was concerned with the effects of a cluster of three variables, only one (mazes) of which was in the Land and Smith study. Also, the Land and Smith study was concerned with the comprehension and application of mathematics concepts and generalizations. The present study dealt with knowledge, comprehension, and application of science facts, concepts, and generalizations. One hypothesis is that the effect of mazes is different in different subject matter areas and for different levels of the cognitive domain (i.e., knowledge versus comprehension). This idea, however, is not supported by Land (1979)

in which he reported a significant inhibitive effect of mazes (3.79 per minute) in a cluster of six variables on the effect of social sciences achievement, or Land (in press) in which he reported no significant differences between knowledge and comprehension learning. An alternative hypothesis is that both mazes and utterances of "uh" are indeed inhibitors but that utterances of "ok" are facilitators of learning.

Within this framework, one must assume that the use of "ok" by teachers is in fact positively related to learning as originally reported by Smith (1977). If that is the case, then the cluster of variables used in the present study contained both inhibitors (mazes and "uh") and facilitators ("ok") and the effects could be expected to cancel each other out.

If this alternative hypothesis is correct, then the author is left with the conclusion that college science teachers should work to decrease the verbal mazes in their presentations (i.e., false starts or halts in speech, redundantly stated words, and tangles of words) and continue to use or even increase the occurrence of "ok" in their presentations. The alternative hypothesis, of course, needs to be tested.

This study supported the contention that students can distinguish between clear and unclear teaching. This finding supports a finding by Smith and Land (in press). One could surmise that student perceived clarity may be as important (or more important) than actual or teacher perceived clarity. Additional research is needed to determine more precisely the effects of teacher clarity on perceived teacher clarity and

achievement in science and of the effects of perceived teacher clarity on achievement.

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FIGURE 1

Low Inference Clarity Variables

Inhibitors

	Previous Research		Present Study
Variable	Significant	Reference	Frequency in the low clarity (unclear) lesson*
1. teacher mazes	no	Smith (1977)	5.1 per minute
	yes	Land & Smith (1979a)	
2. utterances of "uh"	no	Smith (1977)	5.3 per minute
3. utterances of "ok"	yes	Smith (1977)**	5.1 per minute

* These frequencies are based on the descriptive research of Smith (1977).

** Descriptive data by Smith (1977) indicates a positive relationship between this variable and student mathematics achievement. The author of the present study hypothesized that in the quantities indicated, the results would be inhibitive.

FIGURE 2

Lesson Response Form.

What did you think of the teaching?

1.	precise	5*	4	3	2	1	imprecise
2.	decisive	5	4	3	2	1	indecisive
3.	at ease	5	4	3	2	1	not at ease
4.	explains fully	5	4	3	2	1	does not explain fully
5.	content relevant	5	4	3	2	1	content not relevant to main topic
6.	coherent	5	4	3	2	1	incoherent
7.	well-prepared	5	4	3	2	1	not well-prepared
8.	confident	5	4	3	2	1	not confident
9.	well-organized	5	4	3	2	1	not well-organized
10.	speech easy to understand	5	4	3	2	1	speech not easy to understand
11.	speech irritating	1	2	3	4	5	speech soothing
12.	questions clear	5	4	3	2	1	questions not clear
13.	very clear lesson	5	4	3	2	1	lesson not clear at all
14.	speaks too slowly	1	3	5	3	1	speaks too fast
15.	clear and understandable explanations	5	4	3	2	1	confusing explanations

*values given to the response

TABLE 1

Group Mean Achievement Scores

		Teacher Clarity-Actual*	
		High	Low
Teacher Clarity Perceived**	High	N = 10 SD = 2.33 $\bar{X}$ = 17.30	N = 10 SD = 2.54 $\bar{X}$ = 17.22
	Low	N = 10 SD = 2.64 $\bar{X}$ = 16.87	N = 11 SD = 2.86 $\bar{X}$ = 14.90

* F (1,37) = 1.44, $p > .05$

** F (1,37) = 2.62, $p > .05$

TABLE 2

Group Mean Ratings

		Teacher Clarity-Actual*	
		High	Low
Achievement**	High	N = 10 SD = 5.99 $\overline{X}$ = 43.10	N = 11 SD = 9.28 $\overline{X}$ = 28.25
	Low	N = 10 SD = 5.55 $\overline{X}$ = 43.00	N = 10 SD = 7.47 $\overline{X}$ = 23.66

*F (1,37) = 50.25, $p < .01$

**F (1,37) = 1, $p > .05$

TABLE 3

Student Ratings of Lessons

Items		Rating		
		High Clarity Lesson	Low Clarity Lesson	Difference
9.	well-organized not well-organized	4.00	1.84	2.16
8.	confident not confident	3.90	2.12	1.78
7.	well-prepared not well-prepared	3.90	2.22	1.68
15.	clear and understandable explanations confusing explanations	3.60	1.93	1.67
2.	decisive indecisive	3.65	2.05	1.60
10.	precise imprecise	3.80	2.21	1.59
13.	very clear lesson lesson not clear at all	3.45	2.07	1.38
4.	explains fully does not explain fully	3.75	2.41	1.34
6.	coherent incoherent	4.00	2.73	1.27
10.	speech easy to understand speech not easy to understand	3.25	2.12	1.13

TABLE 4

Mean Scores

		Clarity-Actual	
		High	Low
Cognitive Level of Question	Knowledge	N = 20 SD = 1.38 $\bar{X}$ = 4.80	N = 21 SD = 1.13 $\bar{X}$ = 4.15
	Comprehension	N = 20 SD = 1.28 $\bar{X}$ = 4.70	N = 21 SD = 1.63 $\bar{X}$ = 4.45
	Application	N = 20 SD = 1.37 $\bar{X}$ = 3.40	N = 21 SD = 1.34 $\bar{X}$ = 3.25